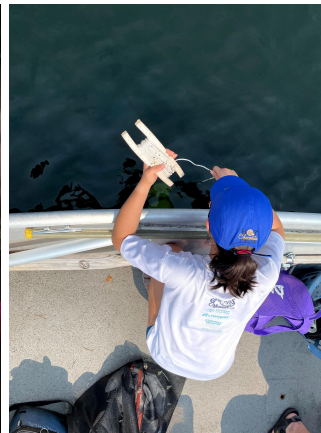


**NRRI Vision:
Discover the Economy of the Future**



Annual Report

Fiscal Year 2021 | July 01, 2020–June 01, 2021

Natural Resources Research Institute

University of Minnesota Duluth



**Natural Resources
Research Institute**

UNIVERSITY OF MINNESOTA DULUTH
Driven to Discover

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Focused on the Future

Greetings from Rolf Weberg, Executive Director, NRRI

If this past year has taught us anything, we've learned that change and adaptation is the new standard. Despite the continuing challenges posed by the effects of the pandemic, NRRI has continued to adjust and deliver with patience, dedication and outstanding teamwork. But we haven't done it alone. We have received critical help and support from our Advisory Board, state legislators and agencies, our partners and collaborators, the University of Minnesota and our fellow citizens. Thank you.



Change has continued across our University community as well. Two of our System leaders and supporters have left for new challenges and we welcome new leadership. NRRI now reports through Interim Executive Vice Chancellor for Academic Affairs, Amy Hietapelto, former UMD dean of the Labovitz School of Business and Economics and long-time supporter of NRRI's mission. The University's Vice President for Research also has interim leadership under Michael Oakes of the University's School of Public Health. We are pleased that Michael's guiding principles – *excellence, integrity, responsiveness and impact* – are fully embraced by NRRI's core values. We look forward to furthering our role under their leadership as a System asset within the University's research enterprise.

Strategic Initiatives

Last year, as we rolled out our 2020-2025 Strategic Plan, we introduced our five research platforms – our key areas of recognized expertise. This year, we are pleased to introduce three strategic initiatives – focal points of our integrated research programs that will deliver real impacts to Minnesota and the region:

1. **Ecosystems and Water Resource Management**
2. **Forestry, Functional Biochar and Carbon Materials**
3. **Iron and Minerals of the Future**

Superimposed upon these is the drive to address the global climate crisis by reducing our carbon footprint in all that we do to maintain our living ecosystems while remaining economically competitive. This focus has brought NRRI new opportunities on the federal level to add our expertise in creating solutions. We will look forward to sharing the results of this work.

Continuous Improvement

Finally, in the spirit of continuous improvement, NRRI has embraced the challenge of assessing our organization based on diversity, equity and inclusion principles. This will be a long-standing effort to create a welcoming and supportive environment for all employees, students, partners and collaborators and I look forward to working with our team in these efforts.

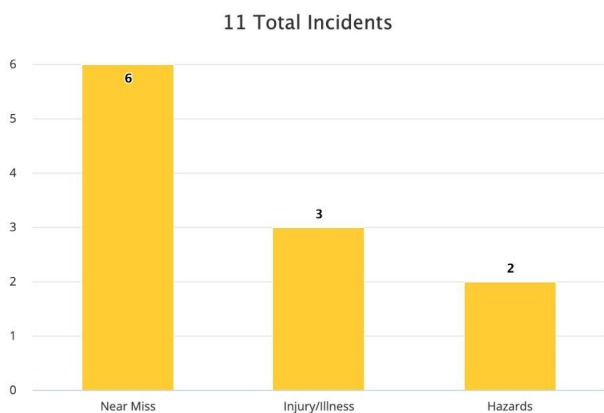
NRRI continues to be a busy and exciting place. I hope that you enjoy this annual report and invite you to share your questions and comments with us. We are *your* Natural Resources Research Institute.

Stay healthy and safe. Thank you for your support,

A handwritten signature in black ink, appearing to read 'Rolf Weberg', written in a cursive style.

FY2021 By the Numbers

People and Safety



Human Resources - New Faces



People and Safety

- 6 Near Miss
- 3 Injury/Illness
- 2 Hazards
- 11 total incidents

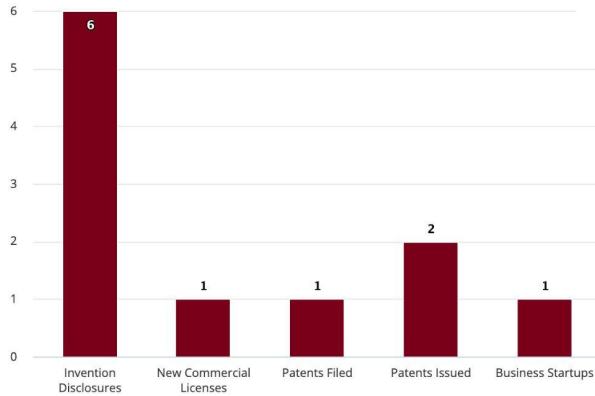
Human Resources

- 11 Full time
- 15 Temp/casuals
- 15 student workers
 - 10 Grad Students
 - 5 Undergrad Students



Postdoc researcher Matthew Berens works on the Sediment Surveillance Survey funded by the U.S. EPA to identify legacy and emerging contaminants in the Great Lakes.

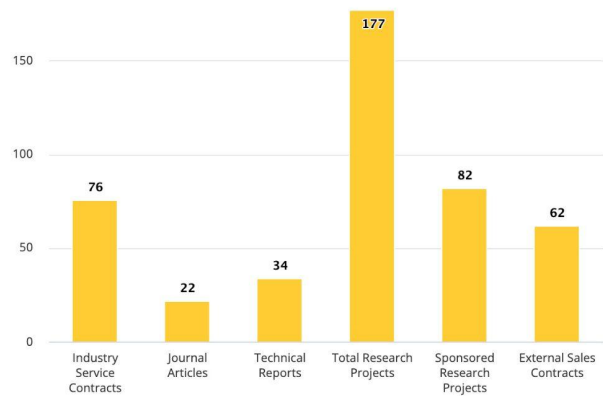
Innovation



Innovation

- 6 Invention Disclosures
- 1 New Commercial Licenses
- 1 Patent Filed
- 2 Patents Issued
- 1 Business Startup

Delivery



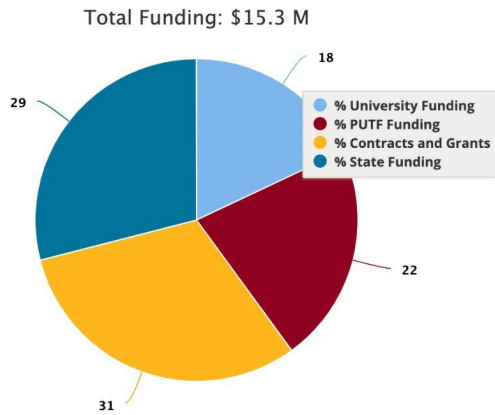
Delivery

- 76 Industry Service Contracts
- 22 Journal Articles
- 34 Technical Reports
- 177 Total Research projects in FY21
- 82 Sponsored Research Projects
- 62 External Sales Contracts

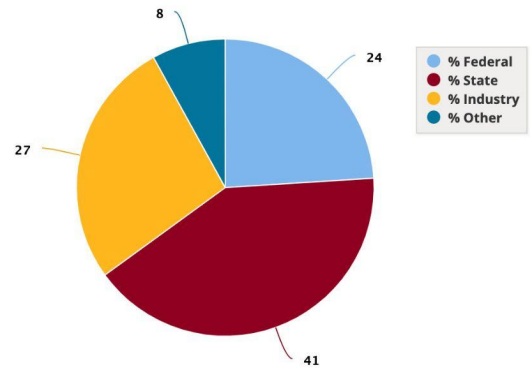
Engagement

- 9 Estimated average number of Zoom meetings per week, per person
- 198 Virtual Conferences & Workshops
- 45 Public Service, Committees
- 9 [MnDRIVE Travel Grants](#) Awarded

Operating Budget



External Contracts and Grants FY20



Operating Budget

- Total funding \$15.3M
- University Funding 18%
- PUTF Funding 22%
- Contracts and Grants 31%
- State Funding 29%

External Contracts and Grants

- Federal 24%
- State 41%
- Industry 27%
- Other 8%



Elizabeth Alexson aboard the EPA's Research vessel, Lake Guardian, before it launched in the Spring, 2021. Alexson is monitoring the critters at the bottom of the food chain in the Great Lakes.

State Funded Research

Cross-platform research projects funded by the Legislative-Citizen Commission on Minnesota Resources ([LCCMR](#)):

- Emerald Ash Borer and Black Ash: Maintaining Forests and Benefits; \$700,000
- Testing Effectiveness of Aquatic Invasive Species Removal Methods; \$110,000
- Bobcat and Fisher Habitat Use and Interactions; \$400,000
- Conserving Black Terns and Forster's Terns in Minnesota; \$198,000
- Lignin-Coated Fertilizers for Phosphate Control; \$250,000

2021 Legislative LCCMR Appropriations:

- Minerals and Water: Demonstration of Three Sulfate Reduction Technology Applications; \$300,000; Next-Generation Technologies and New Iron Products; \$450,000.
- Forest & Bioeconomy: Expansion of Forest Optimization Tool \$500,000; Development of Biochar Capability \$380,000.

2021 Legislative Appropriation

One-time Drop from Higher Education Budget: \$500,000 for infrastructure and research support.

Thanks for supporting our research, Minnesota!



Researchers Cally Hunt and Matt Young inspect and document charred ash wood to produce biochars from beetle-killed trees.

FY2021 Research Impacts and Accomplishments

We are highlighting the work from each of our platforms over the past year. NRRI's research platforms address Minnesota's soil, forest, water and mineral resources.

Applied Ecology and Resource Management

Seeking to understand the world we live in and how to minimize our impacts

Major initiative: Climate change and water management

FY21 Accomplishments & Impacts:

- Received [\\$2.33M from the EPA](#) to support research teams that monitor Great Lakes shorelines as part of the Coastal Wetlands Monitoring Program.
- Received a [\\$3M grant to collect sediments](#) and analyze contaminants throughout the Great Lakes.
- Received \$536,000 to evaluate shipboard ballast water treatment systems and determine the impacts of non-native species introduced to the Great Lakes.
- NRRI and industry partner [patent a first step invention](#) that can lead to sulfate remediation in water systems using altered peat material as a filtering medium.
- Investigating the potential of biochar for stormwater treatment and removal of chemical pollutants.
- Pilot testing two low-cost sulfate remediation technologies to meet Minnesota's sulfate standards in deployable mobile units. One approach uses a unique chemical precipitation and filtration process and the second employs a microbial bioreactor followed by a sulfide capture step using regional mineral materials.
- Made major investment in trace analysis capabilities, including emerging contaminants such as pesticides, flame retardants, plasticizers, solvents and musks.

Minerals and Metallurgy

Defining our mineral resources; demonstrating competitive and responsible use of mineral resources

Major initiative: Minerals & Iron Ore of the Future

FY21 Accomplishments & Impacts:

- Received U.S. Department of Energy (DOE) funding of [\\$2.1M to research Minnesota's iron](#) products for expanded steel making markets.
- Received U.S. DOE Advanced Research Projects Agency-Energy (ARPA-E) funding for "Making Cement at Ambient Temperature Using 55% Municipal Solid Waste Ash." NRRI received \$300,000 as a sub-awardee to project lead, Designs by Natural Processes, Inc., in collaboration with Sandia National Laboratories.
- [High Pressure Grinding Rolls technology](#) was upgraded with industry partner Weir Minerals. This led to four new clients in FY21 that are interested in improving the energy efficiency of their operations.
- Upgraded Coleraine facilities, testing equipment and methods in response to growing requests from Minnesota's mining industry to perform new strategic research projects.
- Assisted startup company, Prairie River Minerals, to complete a [pilot-scale test](#) of their dense medium separation technology which led to the construction of their first industrial-scale demonstration plant near Coleraine, MN.
- NRRI and university collaborators received \$322,250 from the Minnesota Department of Transportation/Local Road Research Board for "Taconite as a lower cost alternative to Calcined Bauxite for high friction surface treatment on low volume roads in Minnesota."
- An award from the U.S. Geological Survey Earth Mapping Resource Initiative (Earth MRI) program was made to a team of researchers from the Minnesota Geological Survey, Department of Natural Resources and NRRI for completion of high resolution aeromagnetic and radiometric geophysical surveys.

Materials and Bioeconomy

Developing new ideas to utilize our forest resources and organic waste streams

Major initiative: Functional Carbon Materials

FY21 Accomplishments & Impacts:

- More than six projects underway to understand the [potential of biochar](#) for environmental remediation and as a new market for forest resources.
- Collaborating with Minnesota Forest Resources Council at the Cloquet Forestry Center to demonstrate opportunities to convert fire hazard trees to biochar to enhance forest regeneration success.
- Industrial scale demonstration projects are underway for multiple clients interested in biomass-based product development for soil fertilization and other unique agricultural, silvicultural and pharmaceutical applications.
- Collaborative research with the U.S. Forest Service shows the bridge construction industry that [building with wood can save](#) time and money while sequestering carbon.
- NRRI and Washington State University are working together to promote [innovations in cross-laminated strand veneer lumber](#) using a heat treatment process.
- NRRI helped social enterprise, [Better Futures Minnesota](#), with a deconstruction and materials resale project in Duluth. The program received a 2021 Environmental Initiative Award.
- Demonstrated better methods to make clean syngas from forest biomass for renewable hydrogen, fuels and metal processing.
- Major investment in material characterization of advanced carbon products from forest biomass, including BET and porosimetry surface characterization.

Data Collection and Delivery

Making complex data accessible and understandable to inform decision-makers

Major initiative: [Minnesota Atlas](#) expanded to a statewide resource

FY21 Accomplishments & Impacts:

- Minnesota [Mammals website](#) was upgraded to meet University usability standards and to be more user-friendly.
- NRRI scientist [published a book](#) titled “Diatom Monographs, Monoraphid and Naviculoid diatoms from the Coastal Laurentian Great Lakes” that includes 28 newly discovered species of diatom algae.
- Completed integrating multiple computer modeling to project 80 years of change in Minnesota's forests to better understand how climate and management decisions impact the ecosystem services they provide.

Commercialization Services

Providing expertise coupled with technical core competencies to drive innovation.

Major initiative: MN LaunchPad for entrepreneurs

FY21 Accomplishments & Impacts:

- Helped establish Launch Minnesota Northeast Minnesota entrepreneurial hub called [Innovate 218](#).
- Implemented Customer Relationship Management (CRM) tool for business and industry engagement.
- Created standardized customer documentation: proposal, budget and statement of qualifications for Business & Industry engagement.

Our Stakeholders and Partner Organizations

NRRI strives to align our capabilities to the goals of our state charter of fostering the economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment.

Agencies/Governmental Units:

- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency
- Minnesota Department of Transportation
- Minnesota Department of Employment and Economic Development
- Minnesota Tribal Governments
- U.S. Environmental Protection Agency
- U.S. Department of Energy
- U.S. Geological Survey
- U.S. Forest Service
- U.S. Department of Agriculture
- Transportation Research Board (part of the National Academies of Sciences, Engineering, and Medicine)

Business & Industry:

- Iron and steel production
- Non-ferrous mining
- Iron ore secondary products
- Paving
- Emerging bioeconomy
- Water treatment and remediation
- Energy sector (biofuels, syngas, green hydrogen, storage)
- Building products
- Forest management
- Entrepreneurial efforts
- Economic Development Organizations

ABOUT NRRI

As part of the University of Minnesota system research enterprise, NRRI employs over 140 scientists, engineers, technicians, staff and students in two industrial research facilities. Through collaborative partnerships, we deliver the innovative tools and solutions needed to utilize and sustain Minnesota's valuable natural resources.

NRRI CHARTER

To foster the economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment.

- Minnesota State Legislature, 1983

NRRI MISSION

Deliver integrated research solutions that value our resources, environment and economy for a sustainable and resilient future.

NRRI VISION

Discover the economy of the future.

NRRI CORE VALUES

- **Safety** | Safety comes first in all that we do.
- **Quality** | There is no compromise on the quality of our work. We aim for top quality in everything we do.
- **Innovation** | The key to our future is innovation. We actively embrace new ideas, tools, approaches and partnerships.
- **Integrity** | Our integrity is the foundation of our public trust; We maintain an honest, unbiased approach in all that we do. We enter all conversations and relationships with respect for one another and the environment.
- **Collaboration** | We continually work to develop and nurture productive relationships. It's how we get things done!
- **Partnership** | We strive to serve our partners and our stakeholders. We actively seek the voice of our rights holders, stakeholders, clients and partners.

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